New Program Approval
Doctor of Philosophy In Applied and
Industrial Mathematics
University of Louisville

Action: The staff recommends that the council approve the Doctor of Philosophy in Applied and Industrial Mathematics proposed by the University of Louisville.

The council staff recommends approval of this program based on evidence of:

- Demand for program graduates.
- Design of the program.
- Collaboration with local industry, the Kentucky Virtual University, and other university departments.
- UofL's ability to implement the program with minimal new resources by providing faculty, facilities, and necessary financial resources.

Demand for Program Graduates

Businesses recognize that computer simulations are replacing experiments in product design to reduce costs and increase flexibility. These simulations require advanced mathematical skills if they are to be used effectively. A university survey of the Louisville industrial area found:

1. The market is large enough to sustain this Ph.D. program.

2. The market is willing to collaborate with UofL's department of mathematics to develop an applied mathematics internship program.

3. The Louisville area companies will hire graduates of the program.

According to the most recent census information, there are 168 computer-based businesses, 19 testing laboratories, 285 scientific consulting services, 19 environmental consulting services, and 12 scientific research and development services in Jefferson County. The Louisville Development Authority and Greater Louisville, Inc., started the eMain USA initiative as a means of revitalizing the downtown area by developing an e-commerce community. To complement

eMain, UofL is developing a high-tech industrial center on its Shelby campus. Such enterprises will require many more people trained in industrial mathematics.

Finally, a 1997 report indicates that Kentucky ranks 47th among the states in the percent of Ph.D. scientists, mathematicians, and engineers in the workforce. Business leaders say that Louisville alone can absorb 3,200 high-tech workers.

Design of the Program

The proposed program is designed according to recommendations of local industry and national organizations such as the Institute of Industrial Mathematics, the Society for Industrial and Applied Mathematics, the American Statistical Association, the American Mathematical Society, and the National Science Foundation. The program emphasizes industrial application of mathematics and includes a mandatory professional internship. Details of program design are available in the attached executive summary.

**Collaboration with Local Industry, the KYVU, and
Other University Departments**

In a survey of local industries to assess program need, every business interviewed was very supportive. All were willing to work with UofL's department of mathematics to develop internships and employ graduates.

The University of Louisville currently offers undergraduate courses via the KYVU. The mandatory industrial internship component of the program includes on-line courses for off-campus and part-time doctoral students. These will be offered through the KYVU and other distance learning formats.

Collaborations are being developed with university departments that have strong mathematics components, such as business, education, psychology, and public health.

Program Implementation

The extra resources needed to conduct the program are minimal, and no new facilities will be required. In anticipation of the program, the department of mathematics has received additional space and laboratory resources. Any additional resources will support graduate assistantships.

Using the Kentucky Postsecondary Program Proposal System, UofL posted the proposed program to the council's Web site. It was reviewed without objection by the other Kentucky public and independent institutions. This program does not duplicate the University of Kentucky's Ph.D. program in mathematics. The UofL program places greater emphasis on

mathematical applications that meet business and industry needs. Graduates will be oriented toward private sector employment, as opposed to teaching and research. Presidents John Shumaker and Lee Todd have identified advanced math as an area for increased collaboration by the two universities. The Board of Trustees approved the program at its June 25, 2001, meeting.

The UofL executive summary of the program proposal is attached.

Staff preparation by Ben Boggs

University of Louisville
Proposed Doctor of Philosophy in Applied and Industrial Mathematics
Executive Summary

Program Description

This is a proposal for a Doctor of Philosophy Degree in Applied and Industrial Mathematics with a suggested CIP Code of 27.0399. It is not in the Program Band for the University of Louisville. The tentative program implementation date is spring, 2002.

The proposed program speaks to the contemporary needs. It will prepare researchers who possess a unique blend of knowledge in mathematics, together with awareness and experience of the applications of that knowledge. Graduates of this program will see mathematics as an integrated whole, with appropriate roles played by applied and industrial needs. The required combination of course work, application area, and industrial internship will enable program graduates to pursue a career in the industrial world.

The program has been designed with the counsel of local industry and national associations. Their recommendations emphasize industrial employment. The following are some needs raised by local industry that a doctoral program focused on industrial employment would address:

- Breadth of training for problem-solving in industry.
- Instruction in oral and written communication of technical material.
- Industrial experience.

Abiding by the recommendations of the national associations, the proposed program incorporates four main components:

- Mandatory internship in an industrial setting.
- Mandatory core of basic mathematics courses.
- Mandatory core of applied mathematics, modeling and statistics courses.
- Mandatory application area to provide breadth of educational experience.

Need and Demand for the Program

A recent report by Governor Patton indicates that Kentucky has a 69% shortage of science and mathematics Ph.D.s[1] and ranks 47th in the percent of Ph.D. scientists, mathematicians, and engineers in the workforce[2]. In order to increase its standing in the amount of scientific research conducted, Kentucky will have to increase its number of highly trained scientists, including mathematicians. Louisville alone can absorb 3200 high tech workers immediately[3]. This year the Carnegie Foundation

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[1] Patton, P.E., *Postsecondary Education in Kentucky, an Assessment*, Report to the Task Force on Postsecondary Education, Frankfort, KY, March 1997.
[2] Strategic Assessment, A Presentation to the Kentucky Science and Technology Council by Walter H. Plosila, Vice President, Public Technology Management, Batelle Memorial Institute, August 22, 1998.
[3] Bill Wolfe. High-tech visa bill may help Louisville. Courier Journal. October 6, 2000.

has designated the University of Louisville for the Advancement of Teaching as one of the "doctoral/extensive research universities – extensive." Implementation of this proposed program would immediately propel UofL and its Department of Mathematics into a small, select group of prestigious universities.[4] That this end is a desirable one is borne out by many commentators. For example, Robert A. Huffman, Executive Director of the Workforce Investment Board of Louisville and Jefferson County, after a visit to the University of Texas in Austin, had this to say about the proposed program:

"One of the things that we learned in Austin is that the existence of a fine, research oriented university is an immense asset when a city pursues economic development. While such a 'town-gown' partnership is always an asset, the benefit is maximized when there is a linkage between technology, education, and entrepreneurship. The elements of this proposed program incorporate just such a linkage."

The surveys of local industries indicate a need for more employees possessing a post-baccalaureate technical degree with knowledge of mathematical modeling and statistical techniques. At the start of the fall 2000 semester, all UofL mathematics students in courses 200-level and above were surveyed concerning their mathematical interests. The majority (65%) indicated a preference for applied courses over theoretical courses and 55% indicated an interest in an internship as part of the mathematics program[5].

Program Options

There are four components to the proposed program[6]:

a. Core	- 24 semester hours.
b. Additional Topics & Area of Specialization	- 18 semester hours.
c. Industrial Internship	- 6 semester hour
d. Doctoral Research and Doctoral Dissertation	- 18-24 semester hours.

In response to the national recommendations, the core consists of required courses in Applied Analysis, Algebra, Discrete Mathematics, Modeling, Probability, and Applied Statistics and allows for flexibility while progressing towards the dissertation. It also provides the basis for a strong master's degree in mathematics.

The Additional Topics & Area of Specialization, consisting of eighteen hours, begins the specialization in a chosen area of research. Some of these courses may be taken in a department outside of mathematics. These courses will add great flexibility to the proposed program. For example, a student might choose courses that would provide a sound basis for applications in Public Health and Decision Science, a program recently instituted at UofL.

The industrial internship is an innovative aspect of this doctoral program. The internship aims to provide:

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[4] *Needs Assessment for the Proposed Doctoral Program in Mathematics: Applied and Industrial* (page 6, National Prominence).
[5] *Needs Assessment for the Proposed Doctoral Program in Mathematics: Applied and Industrial,* page 11.
[6] See Section II of the Proposal.

- first-hand knowledge of how mathematics can be used in industry;
- experience working as part of a team outside of mathematical science;
- experience with the skills required for the use of mathematics in industry.

The graduate programs that have industrial internships observe that they aid in retention and recruitment of students, especially minority and female students.[7]

Industrial Internship

A key component is the industrial internship. In this major component the student will gain valuable experience in using mathematics in nonacademic settings. This working phase will occur after completion of the core and be a semester or summer in duration. The on-site supervisor will have primary responsibility for the student's work, and mathematics faculty members will offer mathematical help to the student as needed. The setting for the major working phase will vary among individuals but will involve an industrial firms, research laboratories, or governmental agencies under the supervision of an experienced practitioner. Several Louisville firms and agencies have already expressed willingness to be involved in this aspect of the program. [8]

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[7] SIAM Northwest Regional Mathematics in Industry Workshop, University of Washington, October 12-14, 2000.
[8] *Needs Assessment for the Proposed Doctoral Program in Mathematics: Applied and Industrial*, Comments from Louisville's Entrepreneurs, Section 10.